Bennettitales

Bennettitales (also known as **cycadeoids**) is an extinct order of seed plants that first appeared in the Permian period[1] and became extinct in most areas toward the end of the Cretaceous (i.e. they existed from about 252 to 66 million years ago),[2] although some Bennettitales appear to have survived into Oligocene times in Tasmania and eastern Australia.[3] The taxon comprises two groups, the Cycadeoidaceae, represented by *Cycadeoidea* and *Monanthesia*, and the Williamsoniaceae including *Williamsonia*, *Williamsoniella*, *Wielandella* and *Ischnophyton* which had slender, branching trunks and either bisporangiate or monosporangiate strobili.[4]

Bennettitales
Temporal range:
Late Permian to Oligocene

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A Cycadeoid, showing an "inflorescence" in the top-right

Scientific classification	
Kingdom:	Plantae
(unranked):	Spermatophyta
Division:	**Cycadeoidophyta**
Order:	**Bennettitales** †

Families

- Cycadeoidaceae
- Williamsoniaceae

Contents

- Description
- Taxonomy
- Gallery
- References
- External links

Description

Originally, Bennettitales were thought to be cycads for their strap-like leaves, however their flower-like reproductive parts separate the two groups. The two families of Bennettitales (Cycadeoidaceae and Williamsoniaceae) each have their own unique traits. Cycadeoidaceae had stout trunks and bisporangiate strobili (cones) serving as their reproductive structures and Williamsoniaceae either had bisporangiate or monosporangiate cones, and distinctly slender and branching woody trunks.[4] These bisporangiate cones consist of layers of protective bracts, a curved microsporophyll, and an ovulate receptacle.[5] The bisporangiate cones remained closed at maturation, and most likely were obligate self-fertilizers.[6]

In general, Bennettitales had leaves attached adaxially (toward the stem) with a distinct midrib. Veins stem from the midrib at an approximately 90 degree angle.[7] They have tough cuticles as well, as they were able to withstand high sulfur dioxide levels in the Triassic/Jurassic period for considerable time.[8] Some were characterized by thick trunks and pinnately compound leaves that bore a superficial resemblance to those of cycads, differing primarily in stomatal arrangement.[9]

Taxonomy

Bennettitales were first identified by Engler in 1892 as separate from Cycadales, and were then further differentiated into the two groups Cycadeoidaceae and Williamsoniaceae by Caruthers. The Euanthial hypothesis erected by Arber and Parking in 1907[10] posited that angiosperms arose from Bennettitales, as evidenced by the wood-like structures and rudimentary flowers. This theory placed them among the anthophytes, leading it to be known more commonly as the Anthophyte hypothesis.[4] Based on morphological data, however, Bennettitales were classified as a monophyletic group when paired with Gnetales.[11] Genetic data showed that modern extant seed-plants form their own monophyletic group, excluding Bennettitales.[2] Modern theory suggests that Bennettitales, Angiosperms, and Gigantopteridales form a clade based on the presence of oleanane.[12] Recent evidence from examining phase-contrast X-ray images of gymnosperm seeds suggested that the Euanthial hypothesis is supported.[13] This is still a hotly debated topic. Mostly, it is understood that by morphological data, Euanthial hypothesis is supported but modern cladistic tests suggest otherwise.[14] Uncovering information about this extinct group is still far from finished, as new species are being discovered such as *Nilssoniopteris binggouensis* in 2014[15] and *Anomozamites sanjiaocunensis* in 2015.[16]

Bennettitales are also linked to the diversification of insects due to their flower-like reproductive parts. Specifically, the origin of insect mouth parts is connected to Bennettitales and Gnetales.[17]

Gallery

A fossilised Bennettite, squashed by later compression.

Side view. Note embedded "flowers".

A flower-like structure.

Fossil leaf of *Zamites mariposana* from the Jurassic.

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External links

- Gymnosperms (http://comenius.susqu.edu/biol/202/archaeplastida/viridiplantae/gymnosperms/cycadeoidophyta/cycadeoidophyta.htm)
- Lecture Notes on Mesozoic Mesophytic Communities (http://www.colby.edu/~ragastal/Paleobotany/mesocommunities.htm)
- Weblinks to articles about the Bennettitales (http://www.equisetites.de/palbot/taxa/bennettitales.html)

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